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        Transparent Interconnection of Lots of Links (TRILL)
         Single Area Border RBridge Nickname for Multilevel
          draft-ietf-trill-multilevel-single-nickname-08.txt

Abstract

   A major issue in multilevel TRILL is how to manage RBridge nicknames.
   In this document, the area border RBridge uses a single nickname in
   both Level 1 and Level 2. RBridges in Level 2 must obtain unique
   nicknames but RBridges in different Level 1 areas may have the same
   nicknames.

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[1](#). Introduction

TRILL (Transparent Interconnection of Lots of Links [[RFC6325](#)]
[[RFC7780](#)]) multilevel techniques are designed to improve TRILL
scalability issues. As described in [[RFC8243](#)], there have been two
proposed approaches. One approach, which is referred to as the
"unique nickname" approach, gives unique nicknames to all the TRILL
switches in the multilevel campus, either by having the Level-
1/Level-2 border TRILL switches advertise which nicknames are not
available for assignment in the area, or by partitioning the 16-bit
nickname into an "area" field and a "nickname inside the area" field.
 The other approach, which is referred to in [[RFC8243](#)] as the
"aggregated nickname" approach, involves assigning nicknames to the

areas, and allowing nicknames to be reused in different areas, by
having the border TRILL switches rewrite the nickname fields when
entering or leaving an area.

The approach specified in this document is somewhat similar to the
"aggregated nickname" approach in [RFC8243] but with very important
difference. In this document, the nickname of an area border RBridge
is used in both Level 1 (L1) and Level 2 (L2). No additional
nicknames are assigned to the L1 areas. Instead, each L1 area is
denoted by the set of all nicknames of those border RBridges of the
area. For this approach, nicknames in L2 MUST be unique but nicknames
inside an L1 areas MAY be reused in other L1 areas that also use this
approach. The use of the approach specified in this document in one
L1 area does not prohibit the use of other approaches in other L1
areas in the same TRILL campus.

2. Acronyms and Terminology

Data Label: VLAN or FGL Fine-Grained Label (FGL)

DBRB: Designated Border RBridge.

IS-IS: Intermediate System to Intermediate System [IS-IS]

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
"SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and
"OPTIONAL" in this document are to be interpreted as described in BCP
14 [RFC2119] [RFC8174] when, and only when, they appear in all
capitals, as shown here.

Familiarity with [RFC6325] is assumed in this document.

3. Nickname Handling on Border RBridges

This section provides an illustrative example and description of the
border learning border RBridge nicknames.

```
         Area {2,20}                level 2              Area {3,30}
   +------------------+     +----------------+     +--------------+
   |                  |     |                |     |              |
   | S--RB27---Rx--Rz----RB2---Rb---Rc--Rd---Re--RB3---Rk--RB44---D |
   |     27           |     |                |     |       44     |
   |              ----RB20---                   ----RB30---       |
   +------------------+     +----------------+     +--------------+
```
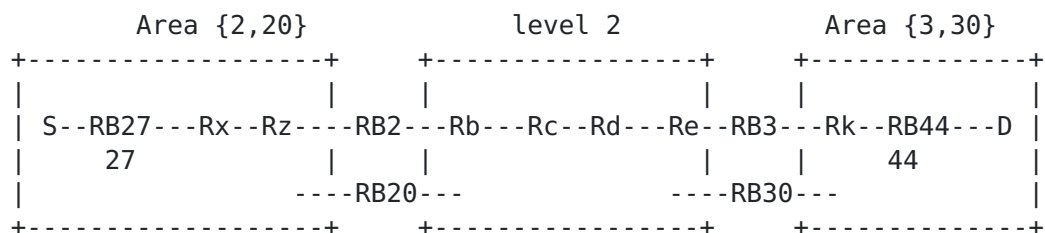
Figure 1: An Example Topology for TRILL Multilevel

In Figure 1, RB2, RB20, RB3 and RB30 are area border TRILL switches

(RBridges). Their nicknames are 2, 20, 3 and 30 respectively and are used as TRILL switch identifiers in their areas [RFC6325]. Area border RBridges use the set of border nicknames to denote the L1 area that they are attached to. For example, RB2 and RB20 use nicknames {2,20} to denote the L1 area on the left.

A source S is attached to RB27 and a destination D is attached to RB44. RB27 has a nickname, say 27, and RB44 has a nickname, say 44 (and in fact, they could even have the same nickname, since the TRILL switch nickname will not be visible outside these Level 1 areas).

3.1. Actions on Unicast Packets

Let's say that S transmits a frame to destination D and let's say that D's location is learned by the relevant TRILL switches already. These relevant switches have learned the following:

1) RB27 has learned that D is connected to nickname 3.
2) RB3 has learned that D is attached to nickname 44.

The following sequence of events will occur:

- S transmits an Ethernet frame with source MAC = S and destination MAC = D.

- RB27 encapsulates with a TRILL header with ingress RBridge = 27, and egress RBridge = 3 producing a TRILL Data packet.

- RB2 and RB20 have announced in the Level 1 IS-IS instance in area {2,20}, that they are attached to all those area nicknames, including {3,30}. Therefore, IS-IS routes the packet to RB2 (or RB20, if RB20 on the least-cost route from RB27 to RB3).

- RB2, when transitioning the packet from Level 1 to Level 2, replaces the ingress TRILL switch nickname with its own nickname, so replaces 27 with 2. Within Level 2, the ingress RBridge field in the TRILL header will therefore be 2, and the egress RBridge field will be 3. (The egress nickname MAY be replaced with an area nickname selected from {3,30}. See Section 4 for the detail of the selection method. Here, suppose nickname 3 is used.) Also RB2 learns that S is attached to nickname 27 in area {2,20} to accommodate return traffic. RB2 SHOULD synchronize with RB20 using ESADI protocol [RFC7357] that MAC = S is attached to nickname 27.

- The packet is forwarded through Level 2, to RB3, which has advertised, in Level 2, its L2 nickname as 3.

- RB3, when forwarding into area {3,30}, replaces the egress

nickname in the TRILL header with RB44's nickname (44). (The ingress nickname MAY be replaced with an area nickname selected from {2,20}. See Section 4 for the detail of the selection method. Here, suppose nickname 2 is selected.) So, within the destination area, the ingress nickname will be 2 and the egress nickname will be 44.

- RB44, when decapsulating, learns that S is attached to nickname 2, which is one of the area nicknames of the ingress.

3.2. Actions on Multi-Destination Packets

Distribution trees for flooding of multi-destination packets are calculated separately within each L1 area and in L2. When a multi-destination packet arrives at the border, it needs to be transitioned either from L1 to L2, or from L2 to L1. All border RBridges are eligible for Level transition. However, for each multi-destination packet, only one of them acts as the Designated Border RBridge (DBRB) to do the transition while other non-DBRBs MUST drop the received copies. All border RBridges of an area MUST agree on a pseudorandom algorithm and locally determine the DBRB as they do in the "Per-flow Load Balancing" section. It's also possible to implement a certain election protocol to elect the DBRB. However, such kind of implementations are out the scope of this document. By default, the border RBridge with the smallest nickname, considered as an unsigned integer, is elected DBRB.

As per [RFC6325], multi-destination packets can be classified into three types: unicast packet with unknown destination MAC address (unknown-unicast packet), multicast packet and broadcast packet. Now suppose that D's location has not been learned by RB27 or the frame received by RB27 is recognized as broadcast or multicast. What will happen, as it would in TRILL today, is that RB27 will forward the packet as multi-destination, setting its M bit to 1 and choosing an L1 tree, flooding the packet on the distribution tree, subject to possible pruning.

When the copies of the multi-destination packet arrive at area border RBridges, non-DBRBs MUST drop the packet while the DBRB, say RB2, needs to do the Level transition for the multi-destination packet. For a unknown-unicast packet, if the DBRB has learnt the destination MAC address, it SHOULD convert the packet to unicast and set its M bit to 0. Otherwise, the multi-destination packet will continue to be flooded as multicast packet on the distribution tree. The DBRB chooses the new distribution tree by replacing the egress nickname with the new root RBridge nickname. The following sequence of events will occur:

- RB2, when transitioning the packet from Level 1 to Level 2,
  replaces the ingress TRILL switch nickname with its own nickname,
  so replaces 27 with 2. RB2 also needs to replace the egress
  RBridge nickname with an L2 tree root RBridge nickname, say 2. In
  order to accommodate return traffic, RB2 records that S is
  attached to nickname 27 and SHOULD use ESADI protocol to
  synchronize this attachment information with other border RBridges
  (say RB20) in the area.

- RB20, will receive the packet flooded on the L2 tree by RB2. It is
  important that RB20 does not transition this packet back to L1 as
  it does for a multicast packet normally received from another
  remote L1 area. RB20 should examine the ingress nickname of this
  packet. If this nickname is found to be a border RBridge nickname
  of the area {2,20}, RB2 must not forwarded the packet into this
  area.

- The packet is flooded on the Level 2 tree to reach both RB3 and
  RB30. Suppose RB3 is the selected DBRB. The non-DBRB RB30 will
  drop the packet.

- RB3, when forwarding into area {3,30}, replaces the egress
  nickname in the TRILL header with the root RBridge nickname, say
  3, of the distribution tree of L1 area {3,30}. (Here, the ingress
  nickname MAY be replaced with a different area nickname selected
  from {2,20}, the set of border RBridges to the ingress area, as
  specified in Section 4.) Now suppose that RB27 has learned the
  location of D (attached to nickname 3), but RB3 does not know
  where D is. In that case, RB3 must turn the packet into a multi-
  destination packet and floods it on the distribution tree of L1
  area {3,30}.

- RB30, will receive the packet flooded on the L1 tree by RB3. It is
  important that RB30 does not transition this packet back to L2.
  RB30 should also examine the ingress nickname of this packet. If
  this nickname is found to be an L2 border RBridge nickname, RB30
  must not transition the packet back to L2.

- The multicast listener RB44, when decapsulating the received
  packet, learns that S is attached to nickname 2, which is one of
  the area nicknames of the ingress.

4. Per-flow Load Balancing

Area border RBridges perform ingress/egress nickname replacement when
they transition TRILL data packets between Level 1 and Level 2. This
nickname replacement enables the per-flow load balance which is
specified as follows.

4.1. Ingress Nickname Replacement

When a TRILL data packet from other areas arrives at an area border
RBridge, this RBridge MAY select one area nickname of the ingress
area to replace the ingress nickname of the packet so that the
returning TRILL data packet can be forwarded to this selected
nickname. The selection is simply based on a pseudorandom algorithm
as defined in Section 5.3 of [RFC7357]. With the random ingress
nickname replacement, the border RBridge actually achieves a per-flow
load balance for returning traffic.

All area border RBridges in an L1 area MUST agree on the same
pseudorandom algorithm. The source MAC address, ingress area
nicknames, egress area nicknames and the Data Label of the received
TRILL data packet are candidate factors of the input of this
pseudorandom algorithm. Note that the value of the destination MAC
address SHOULD be excluded from the input of this pseudorandom
algorithm, otherwise the egress RBridge will see one source MAC
address flip flopping among multiple ingress RBridges.

4.2. Egress Nickname Replacement

When a TRILL data packet originated from an L1 area arrives at an
area border RBridge, that RBridge MAY select one area nickname of the
egress area to replace the egress nickname of the packet. By default,
it SHOULD choose the egress area border RBridge with the least cost
route to reach. The pseudorandom algorithm as defined in Section 5.3
of [RFC7357] may be used as an alternative. In that case, however,
the ingress area border RBridge may take the non-least-cost Level 2
route to forward the TRILL data packet to the egress area border
RBridge.

5. Protocol Extensions for Discovery

5.1. Discovery of Border RBridges in L1

The following Level 1 Border RBridge APPsub-TLV will be included in
an E-L1FS FS-LSP fragment zero [RFC7780] as an APPsub-TLV of the
TRILL GENINFO-TLV. Through listening for this APPsub-TLV, an area
border RBridge discovers all other area border RBridges in this area.

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Type = L1-BORDER-RBRIDGE      | (2 bytes)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Length                        | (2 bytes)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Sender Nickname               | (2 bytes)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

 o Type: Level 1 Border RBridge (TRILL APPsub-TLV type tbd1)

 o Length: 2

 o Sender Nickname: The nickname the originating IS will use as the
    L1 Border RBridge nickname. This field is useful because the
    originating IS might own multiple nicknames.

5.2. Discovery of Border RBridge Sets in L2

   The following APPsub-TLV will be included in an E-L2FS FS-LSP
   fragment zero [RFC7780] as an APPsub-TLV of the TRILL GENINFO-TLV.
   Through listening to this APPsub-TLV in L2, an area border RBridge
   discovers all groups of L1 border RBridges and each such group
   identifies an area.

```
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    | Type = L1-BORDER-RB-GROUP     | (2 bytes)
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    | Length                        | (2 bytes)
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    | L1 Border RBridge Nickname 1  | (2 bytes)
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    | ...                           |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    | L1 Border RBridge Nickname k  | (2 bytes)
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

 o Type: Level 1 Border RBridge Group (TRILL APPsub-TLV type tbd2)

 o Length: 2 * k. If length is not a multiple of 2, the APPsub-TLV is
    corrupt and MUST be ignored.

 o L1 Border RBridge Nickname: The nickname that an area border
    RBridge uses as the L1 Border RBridge nickname. The L1-BORDER-RB-
    GROUP TLV generated by an area border RBridge MUST include all L1
    Border RBridge nicknames of the area. It's RECOMMENDED that these
    k nicknames are ordered in ascending order according to the 2-
    octet nickname considered as an unsigned integer.

   When an L1 area is partitioned [RFC8243], border RBridges will re-
   discover each other in both L1 and L2 through exchanging LSPs. In L2,
   the set of border RBridge nicknames for this splitting area will
   change. Border RBridges that detect such a change MUST flush the
   reach-ability information associated to any RBridge nickname from
   this changing set.

6. One Border RBridge Connects Multiple Areas

It's possible that one border RBridge (say RB1) connects multiple L1 areas. RB1 SHOULD use a single area nickname for all these areas.

Nicknames used within one of these areas can be reused within other areas. It's important that packets destined to those duplicated nicknames are sent to the right area. Since these areas are connected to form a layer 2 network, duplicated {MAC, Data Label} across these areas ought not occur. Now suppose a TRILL data packet arrives at the area border nickname of RB1. For a unicast packet, RB1 can lookup the {MAC, Data Label} entry in its MAC table to identify the right destination area (i.e., the outgoing interface) and the egress RBridge's nickname. For a multicast packet: suppose RB1 is not the DBRB, RB1 will not transition the packet; otherwise, RB1 is the DBRB,

- if this packet originated from an area out of the connected areas, RB1 replicates this packet and floods it on the proper Level 1 trees of all the areas in which it acts as the DBRB.

- if the packet originated from one of the connected areas, RB1 replicates the packet it receives from the Level 1 tree and floods it on other proper Level 1 trees of all the areas in which it acts as the DBRB except the originating area (i.e., the area connected to the incoming interface). RB1 might also receive the replication of the packet from the Level 2 tree. This replication MUST be dropped by RB1. It recognizes such packets by their ingress nickname being the nickname of one of the border RBridges of an L1 area to which the receiving border RBridge is attached.

7. E-L1FS/E-L2FS Backwards Compatibility

All Level 2 RBridges MUST support E-L2FS [RFC7356] [RFC7780]. The Extended TLVs defined in Section 5 are to be used in Extended Level 1/2 Flooding Scope (E-L1FS/E-L2FS) PDUs. Area border RBridges MUST support both E-L1FS and E-L2FS. RBridges that do not support both E-L1FS or E-L2FS cannot serve as area border RBridges but they can appear in an L1 area acting as non-area-border RBridges.

8. Security Considerations

For general TRILL Security Considerations, see [RFC6325].

The newly defined TRILL APPsub-TLVs in Section 5 are transported in IS-IS PDUs whose authenticity can be enforced using regular IS-IS security mechanism [IS-IS] [RFC5310]. This document raises no new security issues for IS-IS.

Using a variation of aggregated nicknames, and the resulting possible duplication of nicknames between areas, increases the possibility of

a TRILL Data packet being delivered to the wrong egress RBridge if
areas are unexpectedly merged. However, in many cases the data would
be discarded at that egress because it would not match a known end
station data label/MAC address.

9. IANA Considerations

IANA is requested to allocate two new types under the TRILL GENINFO
TLV [RFC7357] from the range allocated by standards action for the
TRILL APPsub-TLVs defined in Section 5. The following entries are
added to the "TRILL APPsub-TLV Types under IS-IS TLV 251 Application
Identifier 1" Registry on the TRILL Parameters IANA web page.

```
    Type        Name                    Reference
    ---------   ----                    ---------
    tbd1[256]   L1-BORDER-RBRIDGE       [This document]
    tbd2[257]   L1-BORDER-RB-GROUP      [This document]
```

10. References

10.1. Normative References

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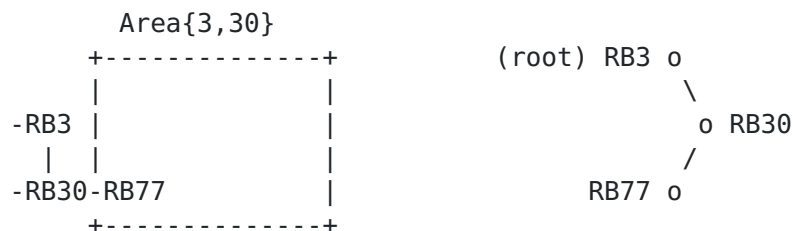## 10.2. Informative References

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             editor.org/info/rfc8243>.

Appendix A. Clarifications

A.1. Level Transition

   It's possible that an L1 RBridge is only reachable from a non-DBRB
   RBridge. If this non-DBRB RBridge refrains from Level transition, the
   question is, how can a multicast packet reach this L1 RBridge? The
   answer is, it will be reached after the DBRB performs the Level
   transition and floods the packet using an L1 distribution tree.

   Take the following figure as an example. RB77 is reachable from the
   border RBridge RB30 while RB3 is the DBRB. RB3 transitions the
   multicast packet into L1 and floods the packet on the distribution
   tree rooted from RB3. This packet will finally flooded to RB77 via
   RB30.

```
            Area{3,30}
            +--------------+          (root) RB3 o
            |              |                      \
         -RB3 |            |                       o RB30
          |  |            |                      /
         -RB30-RB77        |            RB77 o
            +--------------+
```

              Example Topology   L1 Tree

   In the above example, the multicast packet is forwarded along a non-
   optimal path. A possible improvement is to have RB3 configured not to
   belong to this area. In this way, RB30 will surely act as the DBRB to
   do the Level transition.

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